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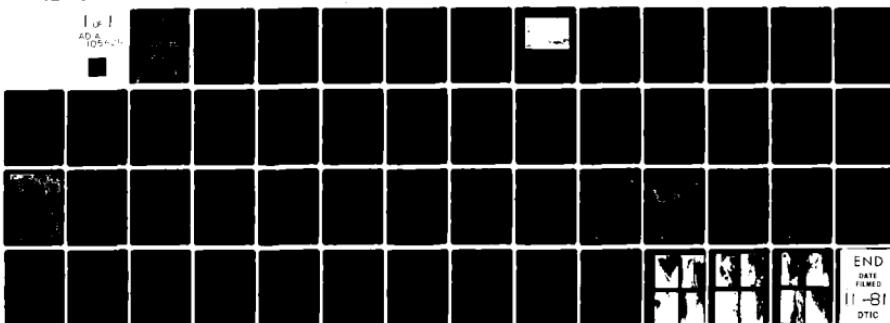
ANDERSON ENGINEERING INC SPRINGFIELD MO
NATIONAL DAM SAFETY PROGRAM. ROLLING HILLS ESTATE LAKE DAM (MO --ETC(U)
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ROLLING HILLS ESTATE LAKE DAM
BUTLER COUNTY, MISSOURI
MO 65077

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Rolling Hills Estates Lake Dam
Butler County, Missouri
Missouri Inventory No. 40077

This report presents the results of field inspection and evaluation of the Rolling Hills Estates Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

SUBMITTED BY:

Chief, Engineering Division

12 NOV 1980

Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

12 NOV 1980

Date

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WHITE RIVER BASIN

ROLLING HILLS ESTATES LAKE DAM
BUTLER COUNTY, MISSOURI
MISSOURI INVENTORY NO. 40077

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

AUGUST, 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam: Rolling Hills Estates Lake Dam
State Located: Missouri
County Located: Butler
Stream: Tributary of Kenner Spring Branch
Date of Inspection: July 18, 1980

Rolling Hills Estates Lake Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of this inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately one mile downstream of the dam. Located within this zone are three dwellings and two trailers.

The dam is in the small size classification, since the maximum storage capacity is greater than 50 ac-ft but less than 1,000 ac-ft.

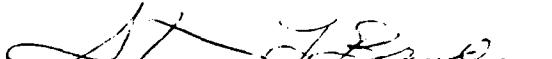
Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 16 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the height of dam (25 feet) and the maximum storage capacity (69 acre-feet),

50 percent of the PMF has been determined to be the appropriate spillway design flood. The 100-year flood (1 percent probability flood) will overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.

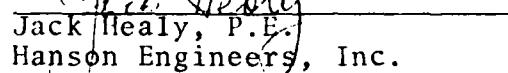
The dam appears to be in good condition. Deficiencies visually observed by the inspection team were: (1) brush and tree growth along upstream and downstream slopes; (2) apparent seepage area at Station 2 + 75 near the toe of the embankment; (3) no wave protection for the upstream face; (4) spillway channel has obstructions at its inlet and outlet; and (4) minor erosion in the spillway channel.

Another deficiency was the lack of seepage and stability analysis records.

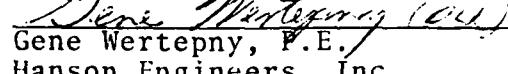
It is recommended that the owners take the necessary action without undue delay to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.



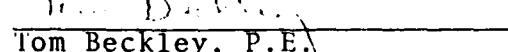
Steven L. Brady, P.E.
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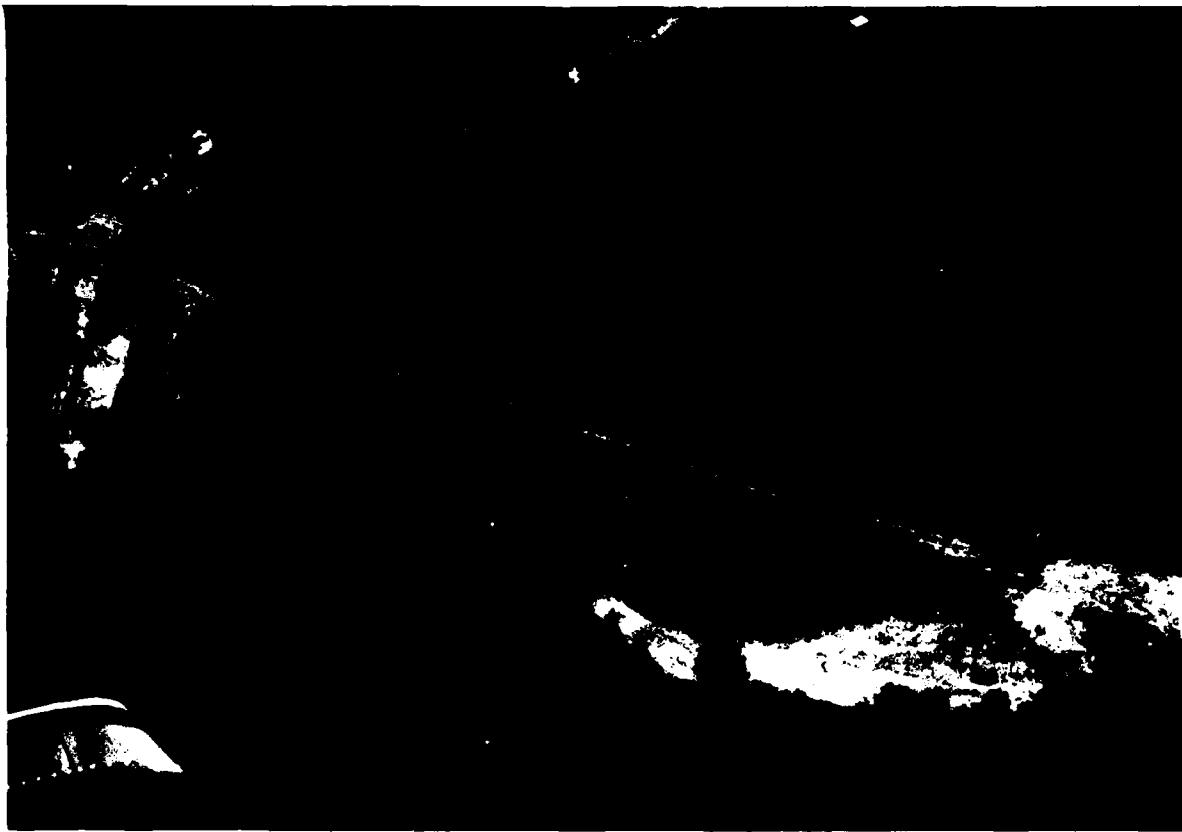
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Anderson Engineering, Inc.



AERIAL VIEW OF LAKE AND DAM

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
ROLLING HILLS ESTATES LAKE DAM
MISSOURI INVENTORY NO. 40077

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Rolling Hills Estates Lake Dam in Butler County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Rolling Hills Estates Lake Dam is an earth fill structure approximately 25 ft high and 425 ft long at the crest. The appurtenant works consist of an earth cut spillway at the west abutment.

Sheet 3 of Appendix A shows a plan, profile, and typical section of the embankment.

B. Location:

The dam is located in the west central part of Butler County, Missouri on a tributary of Kenner Spring Branch. The dam and lake are within the Poplar Bluff, Missouri 7.5 minute quadrangle sheet (Section 02, T24N, R05W - latitude $36^{\circ}45.2'$, longitude $90^{\circ}29.1'$). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 25 ft and a maximum storage capacity of approximately 69 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately one mile downstream of the dam. Located within this zone are three dwellings and two trailers. The location of the affected features was verified by the inspection team.

E. Ownership:

The dam is owned by Mr. Bob Sutton. The owner's address is 632 Vine Street, Poplar Bluff, Missouri (telephone number 314/785-6451).

F. Purpose of Dam:

The dam was constructed primarily for a catfish hatchery.

G. Design and Construction History:

No design information or plans were available. According to Mr. Sutton, the dam was built by a Mr. Ferguson approximately 20 years ago. Mr. Sutton obtained the property by a foreclosure action in January 1972. He stated that Mr. Ferguson was not in the area and that he did not know where he was. No additional information could be obtained from the local populace concerning the dam.

Mr. Sutton stated that he had not done any work to the dam since he purchased it. The present plans for the lake and surrounding area are for lakeside homes to be built.

No information was available about the embankment construction and the location of the borrow.

H. Normal Operating Procedures:

Normal flows are to be passed by the spillway at the west abutment. The maximum pool level was reported to have been within a foot of the crest of the dam.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 102 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 395.7): 150 cfs
- (3) Estimated Capacity of Principal Spillway: 150 cfs
- (4) Estimated Experience Maximum Flood at Dam Site: 75 cfs (approximately 10 percent of PMF)
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 398.0 for top of rock bench Station 0 + 20 centerline of dam (estimated from quadrangle map).

- (1) Top of Dam: 395.7 feet, MSL
- (2) Principal Spillway Crest: 393.5 feet, MSL
- (3) Emergency Spillway Crest: Not Applicable
- (4) Principal Outlet Pipe Invert: Not Applicable
- (5) Streambed at Centerline of Dam: 372.0 feet, MSL

- (6) Pool on Date of Inspection: 392.0 feet, MSL
- (7) Apparent High Water Mark: 394.2 feet, MSL
- (8) Maximum Tailwater: Not Applicable
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 1,100 feet
- (2) At Emergency Spillway Crest: Not Applicable
- (3) At Principal Spillway Crest: 1,000 feet

E. Storage Capacities:

- (1) At Top of Dam: 69 acre-feet
- (2) At Emergency Spillway Crest: Not Applicable
- (3) At Principal Spillway Crest: 54 acre-feet

F. Reservoir Surface Areas:

- (1) At Top of Dam: 7.4 Acres
- (2) At Emergency Spillway Crest: Not Applicable
- (3) At Principal Spillway Crest: 6.5 acres

G. Dam:

- (1) Type: Rolled Earth
- (2) Length at Crest: 425 feet
- (3) Height: 25 feet
- (4) Top Width: 11.0 feet
- (5) Side Slopes: Upstream 1V on 2.2H; Downstream varies from 1V on 1.9H to 1V on 2.9H
- (6) Zoning: Apparently Homogeneous
- (7) Impervious Core: Unknown
- (8) Cutoff: Unknown
- (9) Grout Curtain: Unknown

H. Diversion and Regulating Tunnel:

- (1) Type: Not Applicable
- (2) Length: Not Applicable
- (3) Closure: Not Applicable
- (4) Access: Not Applicable
- (5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

- (1) Location: West Abutment
- (2) Type: Earth Cut Swale
- (3) Upstream Channel: Grass covered earth channel
- (4) Downstream Channel: Heavily wooded earth channel with moderate side slopes

I.2 Emergency Spillway:

- (1) Location: Not Applicable
- (2) Type: Not Applicable

J. Regulating Outlets:

There are no regulating outlets associated with this dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No design computations or reports for this dam are available. No documentation of construction inspection records are known to exist. To our knowledge, there are no documented maintenance data.

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. The top of a rock ledge at Station 0 - 20, centerline of dam, was used as site datum for our survey. From photographs and quad sheets, this datum was estimated to be 398.0 mean sea level elevation.

B. Geology and Subsurface Materials:

The site is located along the southeast edge of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus and deep valleys. The most common bedrock types are dolomite, sandstone, and chert. The "Geologic Map of Missouri" indicates that the bedrock in the site area consists of the Roubidoux formation of the Canadian Series in the Ordovician System. The Roubidoux formation consists of sandstone and dolomite. In the Ozarks region, the thickness of the Roubidoux ranges from 100 to 250 feet.

The publication "Caves of Missouri" indicates that no known caves exist in Butler County.

The "Geologic Map of Missouri" indicates a normal fault passing about 20 miles north of the site in a northeast-southwest direction. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years.

The soils in the area of the dam are of the Nixa-Clarksville-Lebanon-Hobson soil association. These soils have developed from cherty dolomite, limestone, and sandstone. The thickness of loessial deposits in upland areas may range from 2.5 feet to 5.0 feet. The soils adjacent to the reservoir appear to be Clarksville cherty soils. These soils consist of a yellowish-red very cherty silty clay loam. Shallow auger probes into the embankment showed that the embankment was constructed of cherty, silty clay soils. The soils would fall into the Unified Soils Classification of CL.

C. Foundation and Embankment Design:

No foundation or embankment design information was available. Seepage and stability analyses apparently were not performed as required in the guidelines. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

No hydraulic and hydrologic design computations for this dam were available. Based on a field check of spillway dimensions, embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U. S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 through 9.

E. Structure:

There are no structures associated with this dam.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION:

Normal flows are passed by the uncontrolled earth cut spillway at the west abutment. No regulating facilities are associated with this dam. The owner indicated that he had not performed any maintenance on the dam since he purchased it in 1972.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on July 18, 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steven L. Brady, P.E. - Anderson Engineering, Inc. (Civil Engineer)
Jack Healy, P.E. - Hanson Engineers, Inc. (Geotechnical Engineer)
Gene Wertepny, P.E. - Hanson Engineers, Inc. (Hydrologic Engineer)
Tom Beckley, P.E. - Anderson Engineering, Inc. (Civil Engineer)

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The embankment appears to be in good condition. No sloughing of the embankment was noted. The horizontal and vertical alignments of the crest appeared good, and no surface cracking or unusual movement was obvious. The crest of the embankment was 11 feet wide, and the low point elevation was 395.7 feet MSL.

The upstream face of the embankment has a slope of 1V on 2.2H from the crest to the water surface. Some small trees and brush were noted on the slope. The surface of the slope was generally gravel covered with scattered grass cover. The small gravel does not appear to provide significant wave protection. Near the earth cut spillway at the west abutment, an 8 inch cast iron pipe was noted, extending from the embankment toward the water. This pipe was about 2 feet above the water surface. No outlet for the pipe was located. The owner stated that he did not know the purpose of the pipe and was unaware of any outlet of the pipe.

The downstream slope of the embankment varied from 1V on 1.9H to 1V on 2.9H. A slight grass cover was observed on the slope. Scattered small trees and brush were noted on the embankment. Erosion channels were noted at each abutment-embankment contacts. A wet area was observed at the downstream toe of the slope near Station 2 + 75. No measureable flow was detected. The surface of the slope was generally gravelly with a number of larger boulders. No animal burrows were noted.

Shallow auger probes into the embankment indicate the dam to consist of a brownish red, gravelly, sandy clay with some silt and chert fragments (CL).

No instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Principal Spillway:

The principal spillway is an earth cut channel located at the west abutment. A growth of cattails and light brush was noted at the spillway inlet. Some erosion of the channel was noted. There was an intentional partial blockage of the channel about 150 feet downstream of the centerline of the dam. This consisted of a wire mesh screen erected in the channel (see Photograph No. 9). Silt and debris accumulated on the upstream side of the screen. The spillway channel is well separated from the embankment.

C.2 Emergency Spillway:

There is no emergency spillway associated with this dam.

D. Reservoir:

The watershed is generally wooded and grass covered with mild slopes. Future development includes the construction of additional houses surrounding the area. No sloughing or serious erosion of the reservoir area was noted. Considerable silting of the reservoir was noted.

E. Downstream Channel:

The downstream channel is relatively well defined, heavily wooded with moderate side slopes.

3.2 EVALUATION:

The brush and trees on the embankment can provide shelter for small animals and encourage burrowing. The wet area at the toe of the dam could affect the stability of the dam. The erosion areas at the embankment-abutment contacts could worsen and also affect the stability of the dam. The wet area and the eroded areas should be investigated by an engineer experienced in the design and construction of dams.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no operating facilities associated with this dam. The pool level is normally controlled by rainfall, runoff, evaporation, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM:

The owner stated that he had not provided maintenance since he purchased the dam in 1972.

4.3 MAINTENANCE OF OPERATING FACILITIES:

There are no operating facilities for this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The brush and tree growth on the dam and spillway channel, lack of riprap, seepage at the toe of the embankment, erosion channels in the embankment and spillway channel, and a non-erodible spillway control section are deficiencies which could become serious.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. Information from the owner indicates that the high water level has been to within about a foot of the crest of the dam. The apparent high water elevation observed by the inspection team was elevation 394.2. Our hydrologic and hydraulic analyses using U. S. Army Corps of Engineers guidelines, appear in Appendix C.

C. Visual Observations:

The approach area to the spillway has some blockage due to brush and small trees. The downstream channel is heavily wooded and brushy. There is no non-erodible spillway control section. The spillway outlet channel is diverted away from the embankment and spillway releases would not be expected to endanger the dam.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U. S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevations; and (2) an estimate of the reservoir storage and the pool and drainage areas from the Poplar Bluff, Missouri 7.5 minute U.S.G.S. quad sheet.

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 16 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the height of dam (25 feet) and the maximum storage capacity (69 acre-feet), 50 percent of the PMF has been determined to be the appropriate spillway design flood.

The spillway will not pass a 1 percent probability flood without overtopping the dam.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 2,454 cfs. For 50 percent of the PMF, the peak inflow was 1,227 cfs.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.5 ft at elevation 397.2. The duration of the overtopping will be 6.6 hours, and the maximum outflow will be 2,270 cfs. The maximum discharge capacity of the spillway is 150 cfs at elevation 395.7. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 1.0 ft at elevation 396.7. The maximum outflow will be 1,073 cfs, and the duration of overtopping will be 4.3 hours. The routing of the 1 percent probability flood through the spillway and dam indicates that the dam will be overtopped by 0.4 ft at elevation 396.1. The maximum outflow will be 289 cfs, and the elevation of duration of overtopping will be 0.7 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

No post-construction changes to the dam have been reported.

E. Seismic Stability:

The structure is located in seismic zone 2. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) brush and tree growth on the embankment; (2) brush and tree growth at the inlet and outlet of the spillway channel; (3) seepage at the toe of the embankment; (4) erosion channels in the embankment slopes and spillway channel; and (5) a non-erodible spillway control section.

Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 16 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. The items recommended in paragraph 7.2A should be pursued without undue delay.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no additional inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 2. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

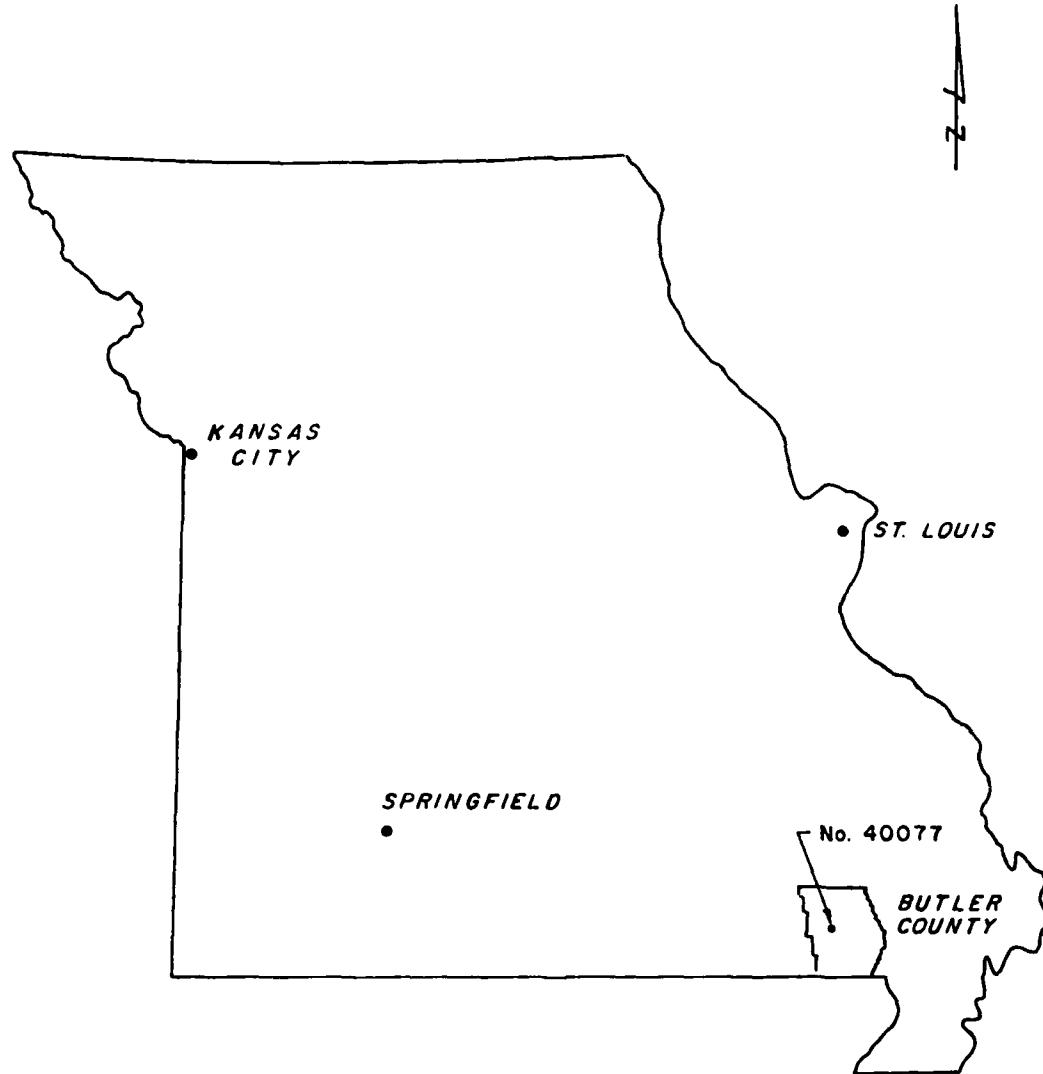
- (1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case the spillway should be protected to prevent erosion.

B. O & M Procedures.

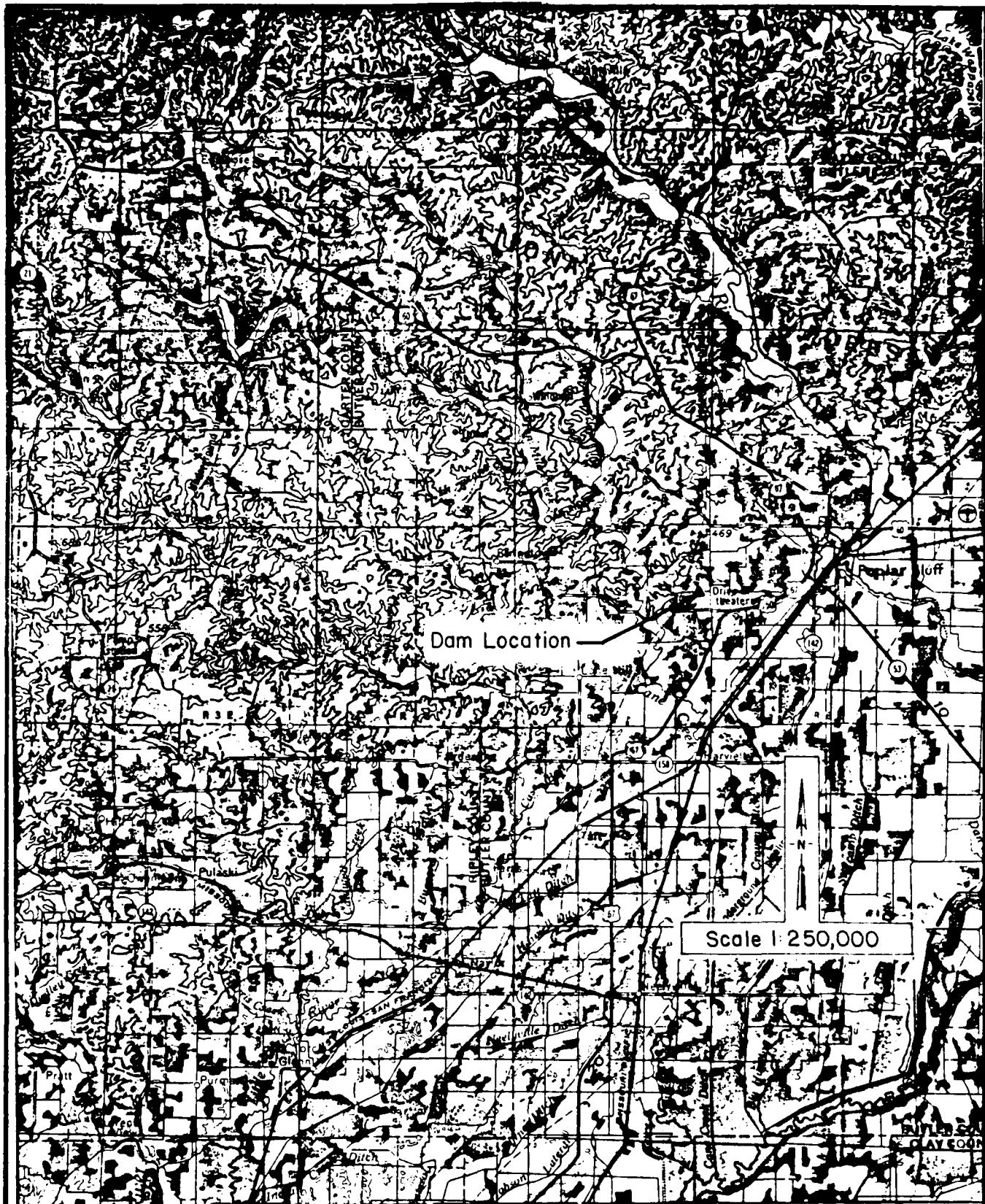
- (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.
- (2) A non-erodible spillway control section should be provided so that progressive erosion of the spillway would not lower the normal pool of the reservoir.
- (3) Wave protection should be provided for the upstream face of the dam.
- (4) Brush and tree growth should be removed from the embankment and the spillway channel. This should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam.
- (5) The eroded areas on the embankment should be repaired, seeded, and maintained.
- (6) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans



LOCATION MAP



VICINITY MAP



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Rolling Hills Estates Lake Dam
Butler County, Missouri
Mo. I.D. No. 40077

Sheet 2, Appendix A

5 +00

4 +00

3 +00

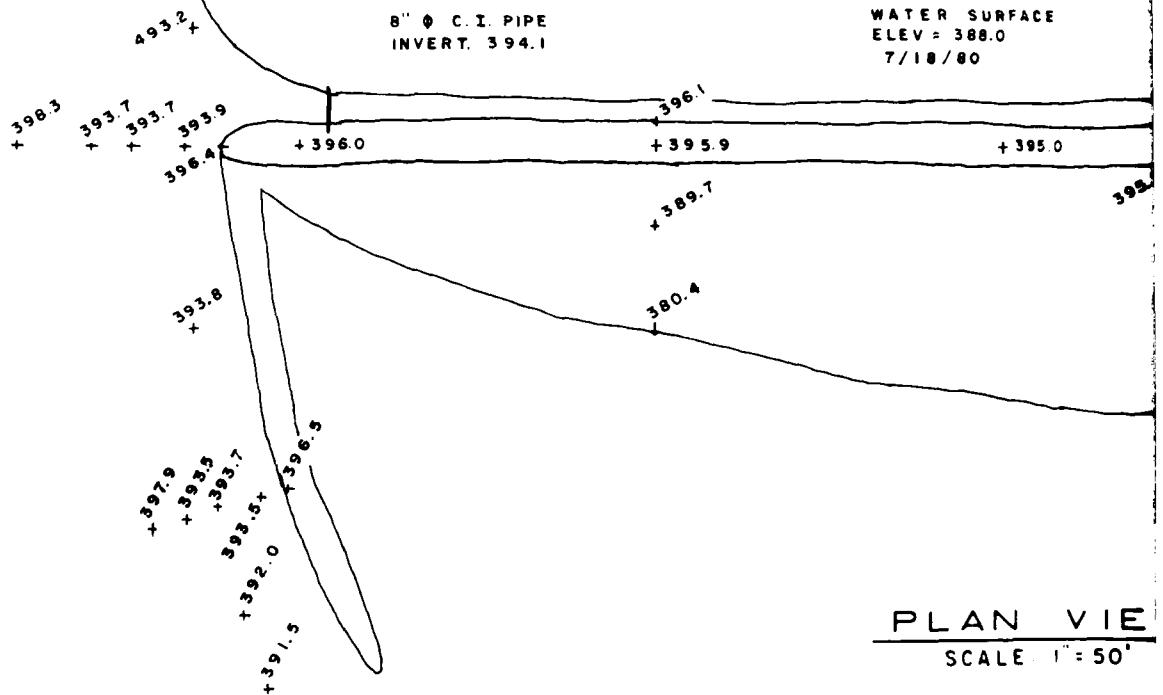
2 +00

Z

LAKE

8" Ø C.I. PIPE
INVERT. 394.1

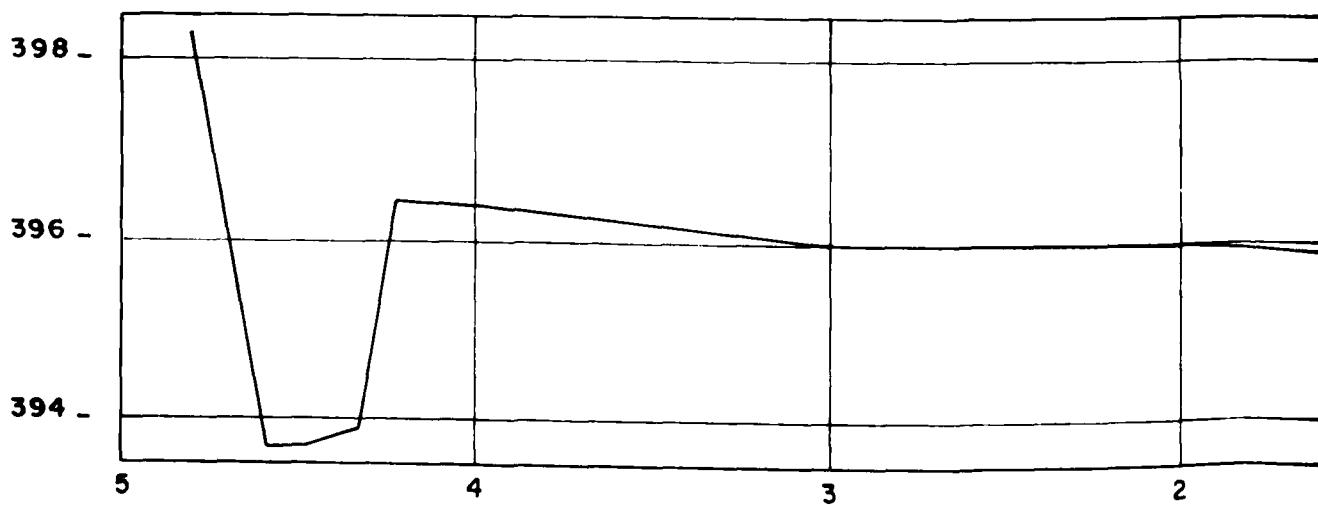
WATER SURFACE
ELEV = 388.0
7/18/80



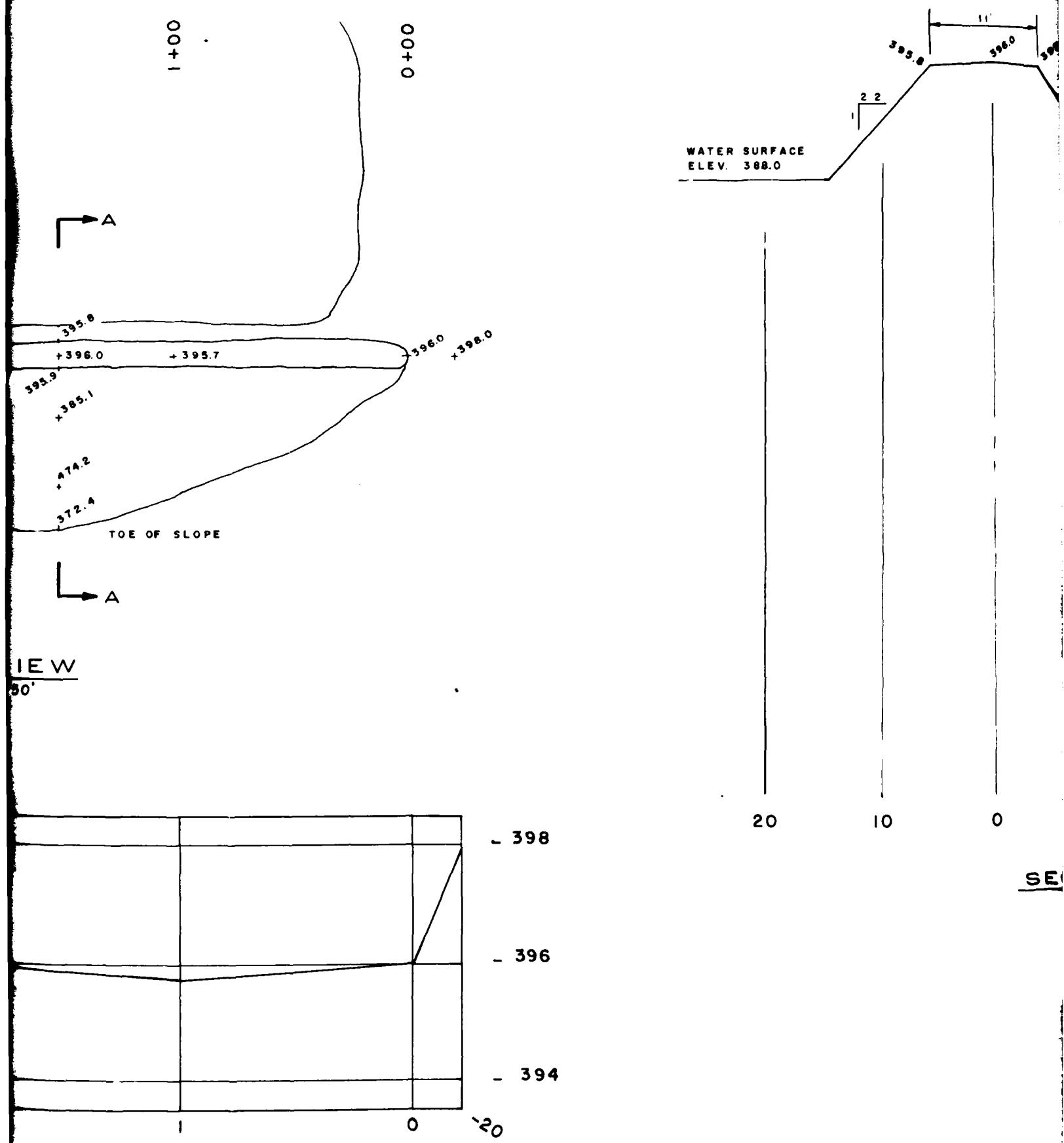
PLAN VIE

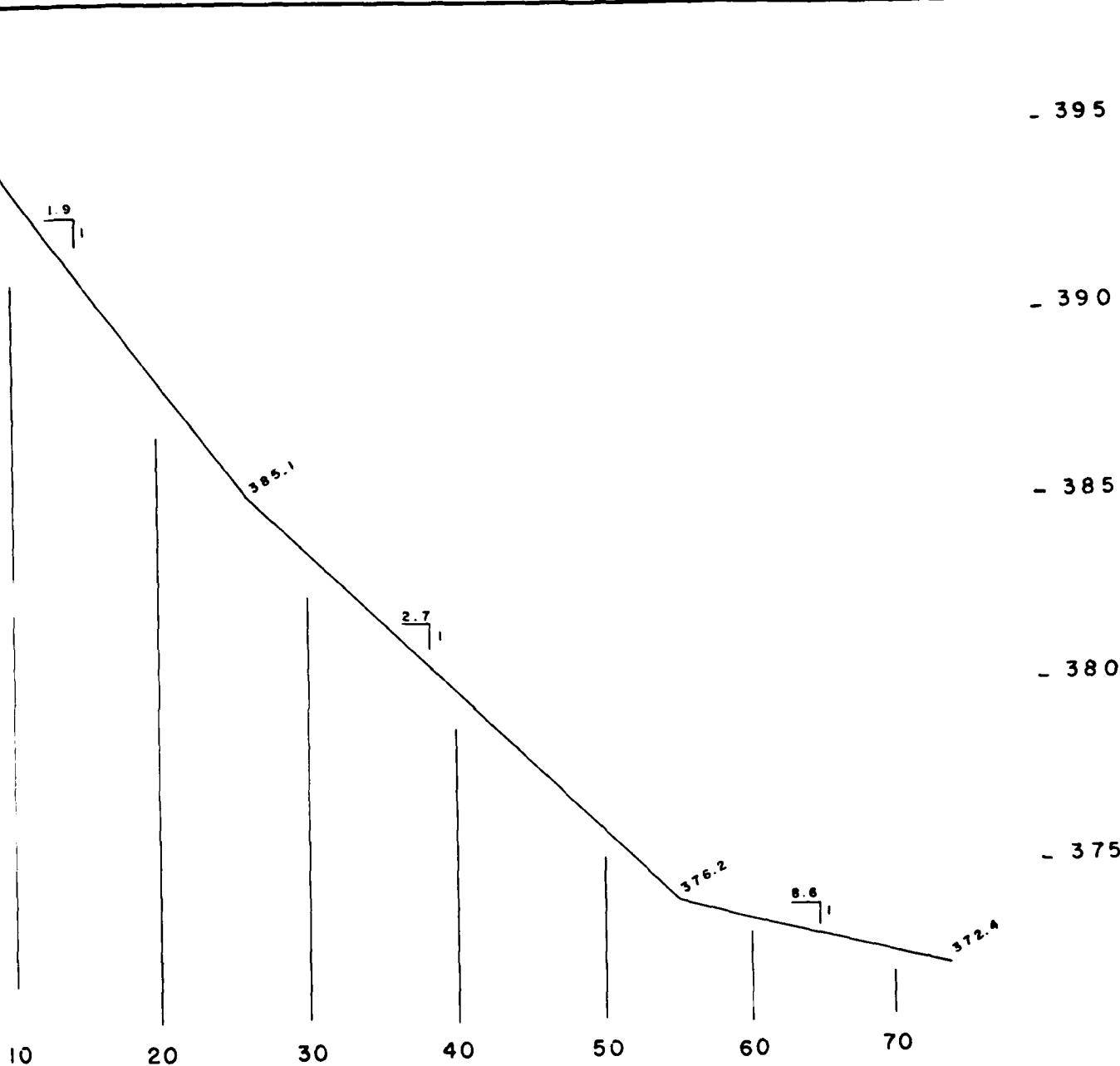
SCALE 1" = 50'

BENCHMARK:
TOP OF ROCK AT STA 0-20
CENTERLINE OF DAM
ELEV. = 398.0



PROFILE





SECTION A-A STA 1 + 50

SHEET 3

ANDERSON EN
730 NORTH E
SPRINGFIELD

ROLLING
LAD
MO.

PLAN

BUTLI

- 395

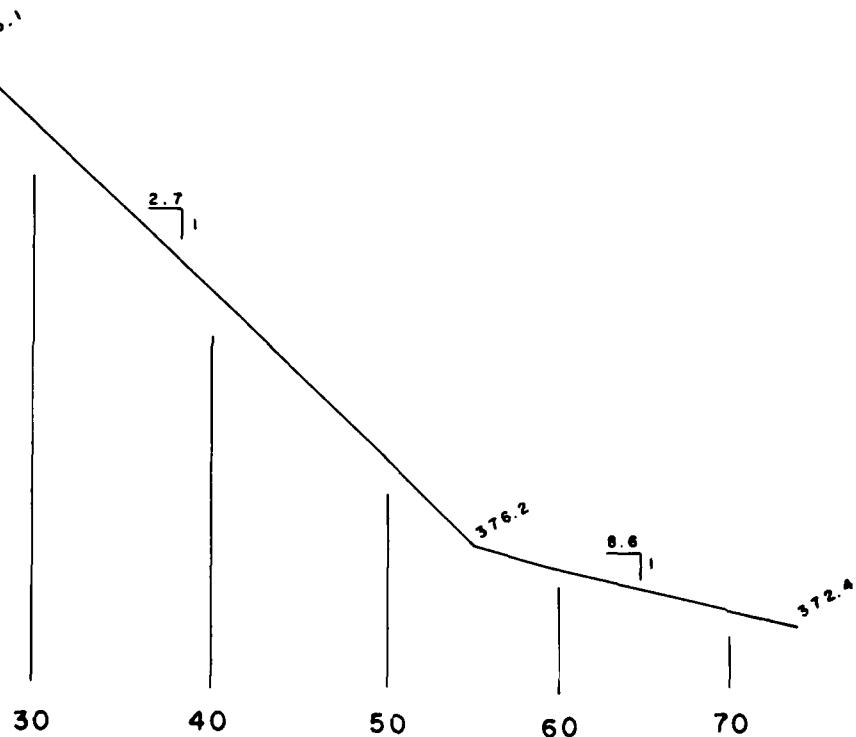
- 390

- 385

- 380

- 375

STA 1 + 50



SHEET 3 APPENDIX A

ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

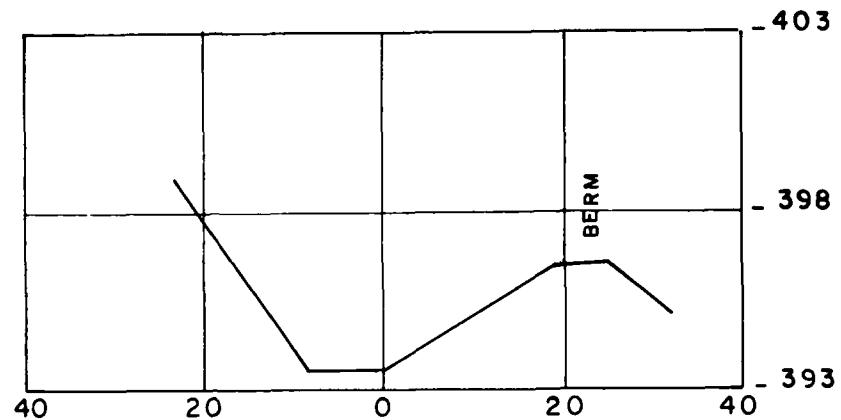
ROLLING HILLS ESTATES
LAKE DAM

MO. No. 40077

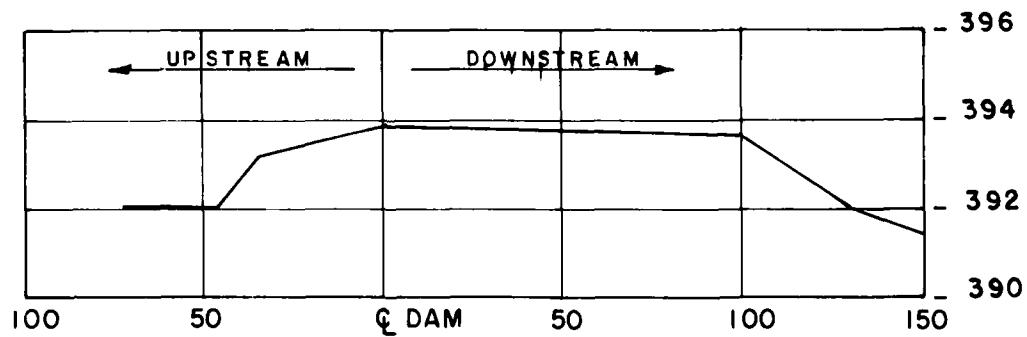
PLAN & PROFILE

BUTLER COUNTY, MO.

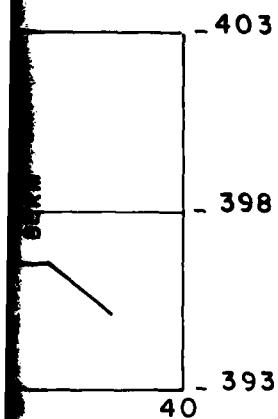
3



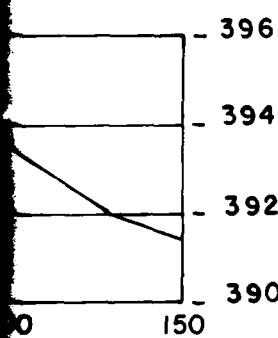
SPILLWAY SECTION
100 FT DOWNSTREAM $\&$ DAM



SPILLWAY PROFILE



N
M



SHEET 3A APPENDIX A

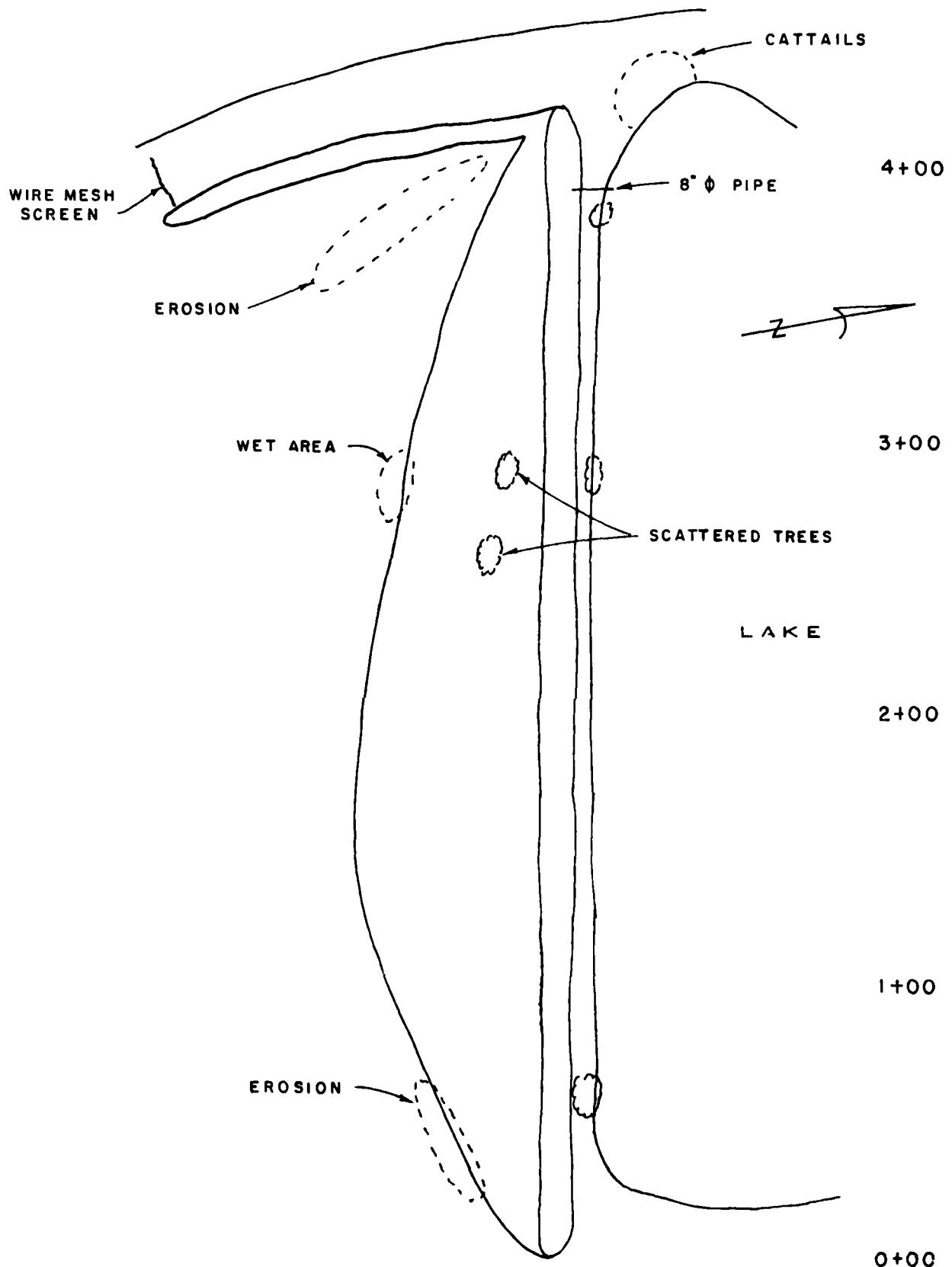
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

ROLLING HILLS ESTATES
LAKE DAM

MO. No. 40077

SPILLWAY
SECTION & PROFILE
BUTLER COUNTY, MO.

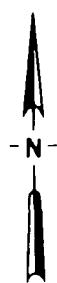
2



PLAN SKETCH OF DAM
ROLLING HILLS ESTATES LAKE DAM
MO. No. 40077

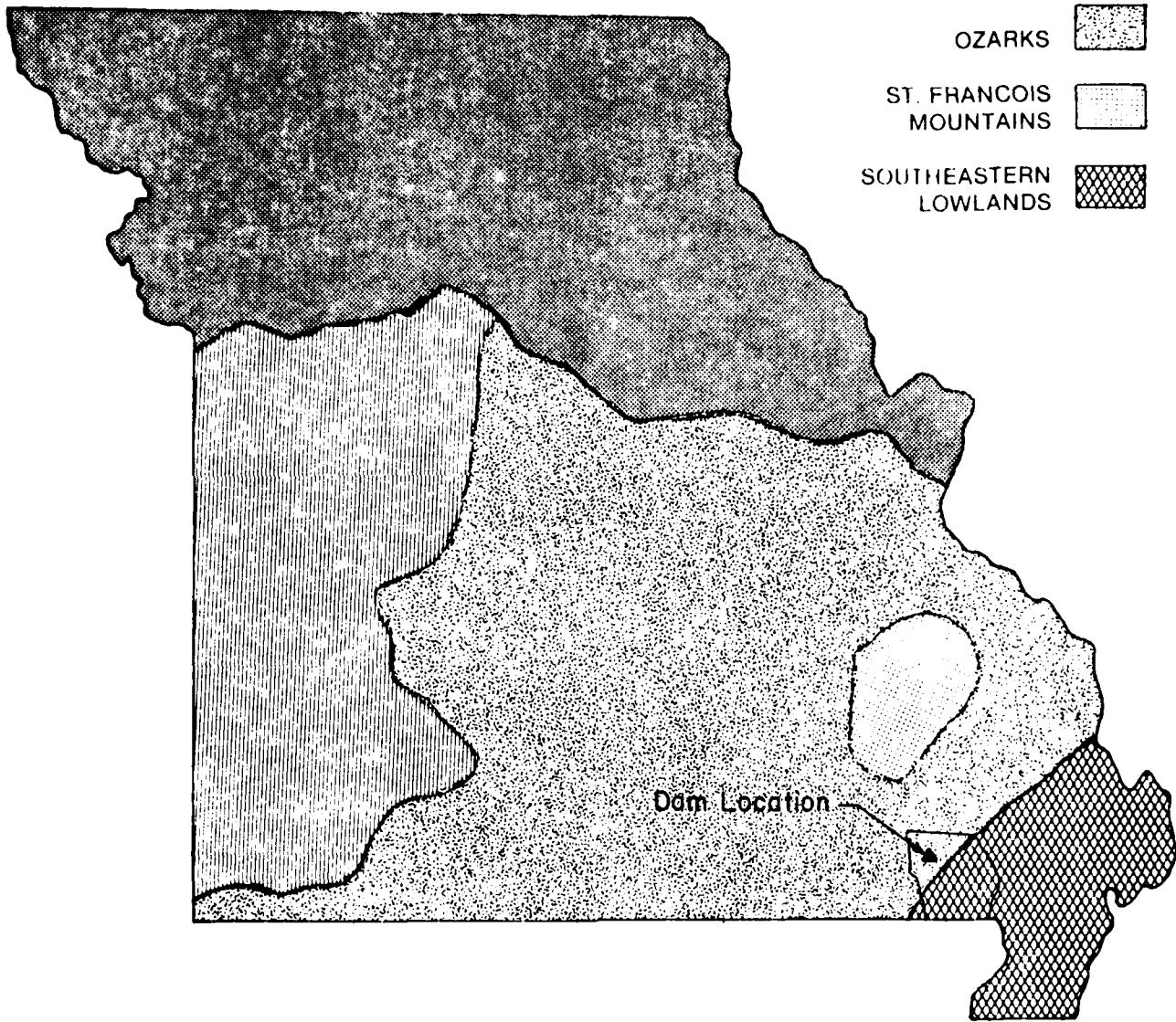
APPENDIX B

Geology and Soils



LEGEND

GLACIATED PLAINS	
WESTERN PLAINS	
OZARKS	
ST. FRANCOIS MOUNTAINS	
SOUTHEASTERN LOWLANDS	



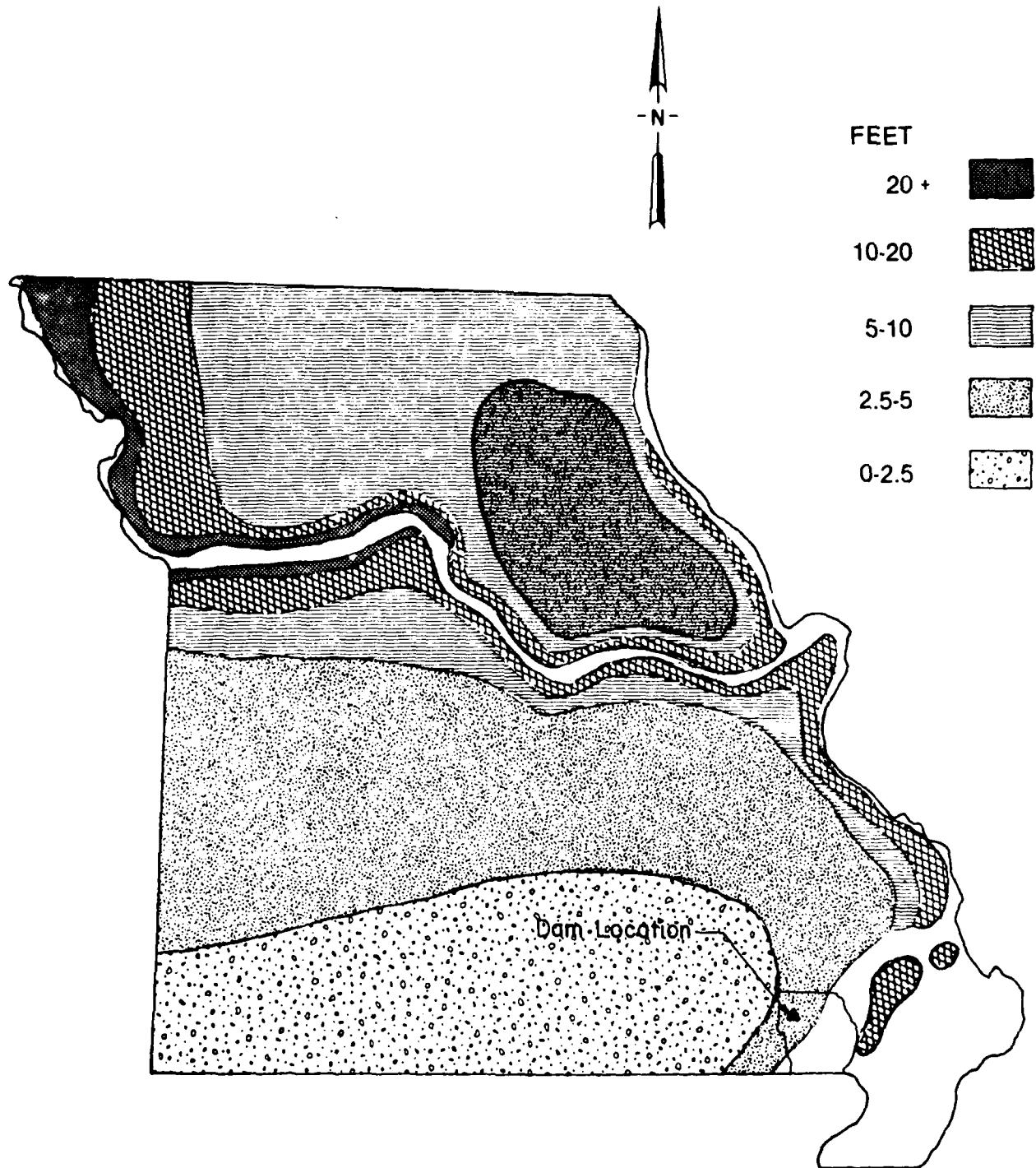
MAJOR GEOLOGIC REGIONS OF MISSOURI



SPRINGFIELD, IL • PEORIA, IL • HUCKFORD, IL

Rolling Hills Estates Lake Dam
Butler County, Missouri
Mo. I.D. No. 40077

SHEET 1, APPENDIX B



THICKNESS OF LOESSIAL DEPOSITS



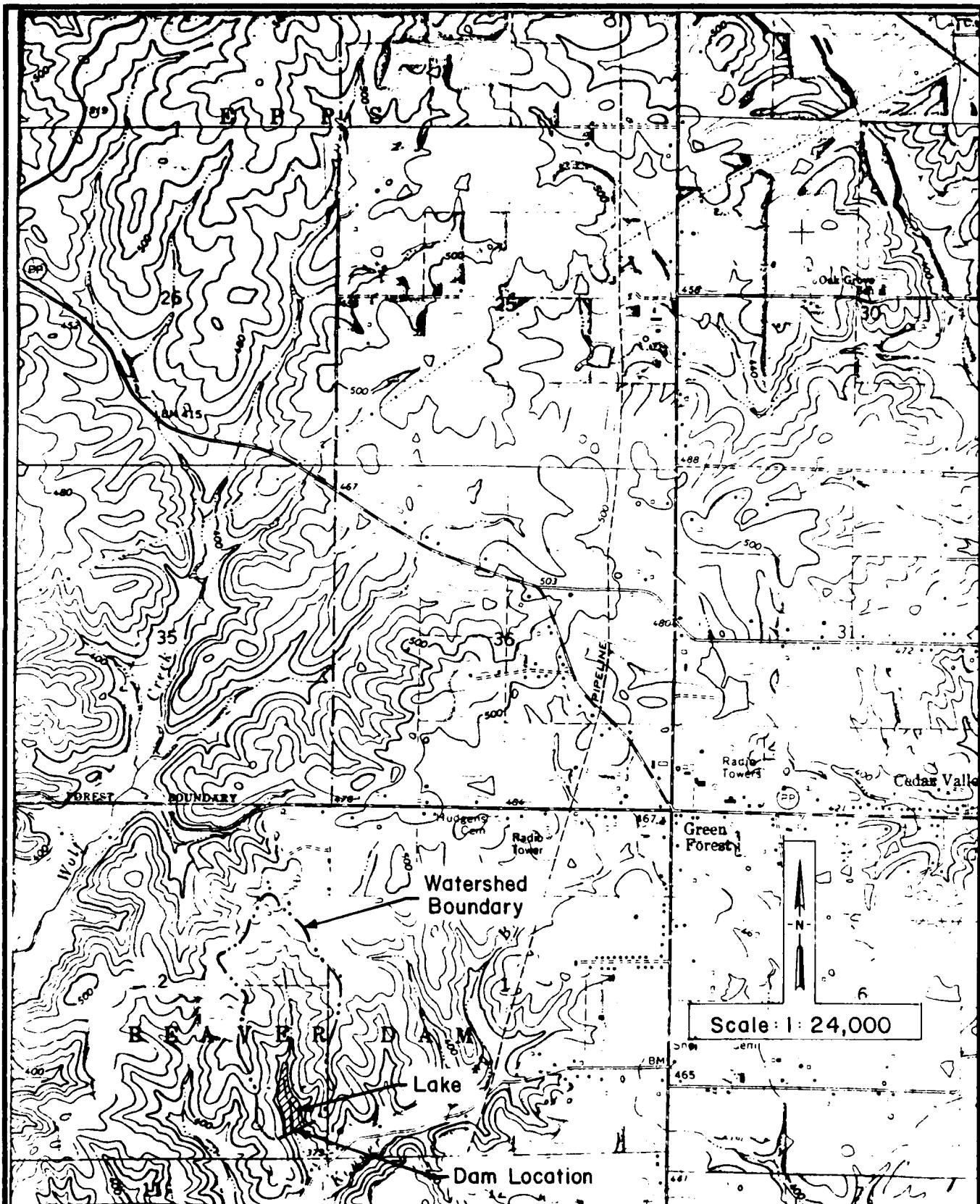
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Rolling Hills Estates Lake Dam
Butler County, Missouri
Mo. I.D. No. 40077

SHEET 2, APPENDIX B

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Rolling Hills Estates Lake Dam

Butler County, Missouri

Mo. I.D. No. 40077

Sheet 1, Appendix C

APPENDIX C
HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. Doniphan rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The parameters for the unit hydrograph are shown in Table 1 (Sheet 3, Appendix C).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2 (Sheet 4, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area--storage-discharge relationships shown in Table 3 (Sheet 4, Appendix C.)

The rating curve for the spillways (see Table 4, Sheet 5, Appendix C) was determined assuming open channel flow.

The flow over the crest of the dam during overtopping was determined using the non-level dam option (\$L and \$V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 6, Appendix C).

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 7, 8 and 9 of Appendix C.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	0.16 sq miles
Length of Watercourse (L)	0.50 miles
Difference in elevation (H)	112 ft
Time of concentration (Tc)	0.19 hrs
Lag Time (Lg)	0.11 hrs
Time to peak (Tp)	0.15 hrs
Peak Discharge (Qp)	516 cfs
Duration (D)	5 min.

<u>Time</u> (Min.) (*)	<u>Discharge</u> (cfs) (*)
0	0
5	289
10	508
15	262
20	107
25	44
30	18
35	7
40	3
45	0

(*) From the computer output

FORMULA USED:

$$T_c = \left(\frac{11.9 L^3}{H} \right)^{0.385} \quad \text{From California Culverts Practice, California Highways and Public Works, September, 1942.}$$

$$Lg = 0.6 T_c$$

$$T_p = \frac{D}{2} + Lg$$

$$Q_p = \frac{484 A \cdot Q}{T_p} \quad Q = \text{Excess Runoff} = 1 \text{ inch}$$

TABLE 2
RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	35.88	34.83	1.04
1% Prob. Flood	24	7.55	5.44	2.11

Additional Data:

- 1) Soil Conservation Service Soil Group D
- 2) Soil Conservation Service Runoff Curve CN = 91 (AMC III) for the PMF
- 3) Soil Conservation Service Runoff Curve CN = 80 (AMC II) for the 1 percent chance flood
- 4) Percentage of Drainage Basin Impervious 10 percent

TABLE 3
ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

Elevation (ft, MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
372.0	0	0	-
380.0	1.0	3.0	-
*393.5	6.5	54.0	0
**395.7	7.4	69.0	150
398.0	8.3	87.0	650
400.0	9.2	105.0	1,330

* Principal spillway crest elevation

**Top of dam elevation

The above relationships were developed using data from the USGS Poplar Bluff, MO 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

<u>Reservoir Elevation (MSL)</u>	<u>Principal Spillway (cfs)</u>
393.5	0
394.0	12
394.5	39
395.0	77
395.5	125
*395.7	150
396.0	200
396.5	290
397.0	400
397.5	520
398.0	650
400.0	1,330

*Top of dam elevation

METHOD USED: Assuming open channel flow.

Using charts from "UD Method of Reservoir Flood Routing,"
S.C.S. Technical Release No. 35, February 1967.

TABLE 5
RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft, MSL)	Total Storage (acre-ft)	Peak Outflow (cfs)	Depth (ft.) Over Top of Dam
-	0	*393.5	54.0	0	0
0.10	245	395.1	65.0	82	0
0.15	368	395.6	68.0	139	0
0.16	393	**395.7	69.0	150	0
0.20	491	396.0	71.0	237	0.3
0.25	614	396.2	73.0	401	0.5
0.30	736	396.4	74.0	590	0.7
0.40	982	396.5	75.0	850	0.8
0.50	1,227	396.6	76.0	1,073	1.0
0.75	1,841	396.9	79.0	1,668	1.2
1.00	2,454	397.2	81.0	2,270	1.5

The percentage of the PMF that will reach the top of the dam is 16 percent.

* Principal spillway crest elevation

**Top of dam elevation

A OVERTOPPING ANALYSIS FOR ROLLING HILLS ESTATES LAKE DAM (# 23)
A STATE ID NO. 40077 COUNTY NAME : BUTLER
A HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 8053001

B	300	5					
B1	5						
J	1	9	1				
J1	.10	.15	.20	.25	.30	.40	.50
K	0	1					
K1	INFLOW HYDROGRAPH COMPUTATION **						
H	1	2	0.16				
P	0	27.6	102	120	130		
T						-1	-91
W2	0.19	0.11					
X	0	-.1	2				
K	1	2		0	4	1	
K1	RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **						
Y				1			
Y1	1						
Y4	393.5	394.0	394.5	395.0	395.5	395.7	396.0
Y4	398.0	400.0					
Y5	0	12	39	77	125	150	200
Y5	650	1350					
\$5	0	3	54	69	87	105	
\$E	372.0	380.0	393.5	395.7	398.0	400.0	
\$\$	393.5						
\$D	395.7						
\$L	0	200	405	427	430	440	
\$V	395.7	396.0	396.1	396.4	397.0	398.0	
K	99						

PMF RATIOS INPUT DATA

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIOS APPLIED TO FLOWS					RATIO 6	RATIO 7	RATIO 8	RATIO 9
					RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6				
HYDROGRAPH AT	1 (0.41)	0.16 (0.41)	1 (6.95)	245. (10.42)	368. (13.90)	491. (17.37)	614. (20.85)	736. (27.80)	982. (34.75)	1227. (52.12)	1841. (69.50)	2454.	
ROUTED TO	2 (0.41)	0.16 (0.41)	1 (2.32)	82. (3.94)	139. (6.70)	237. (11.34)	401. (16.70)	590. (24.07)	850. (30.38)	1073. (47.23)	1668. (64.28)	2270.	

SUMMARY OF DAM SAFETY ANALYSIS

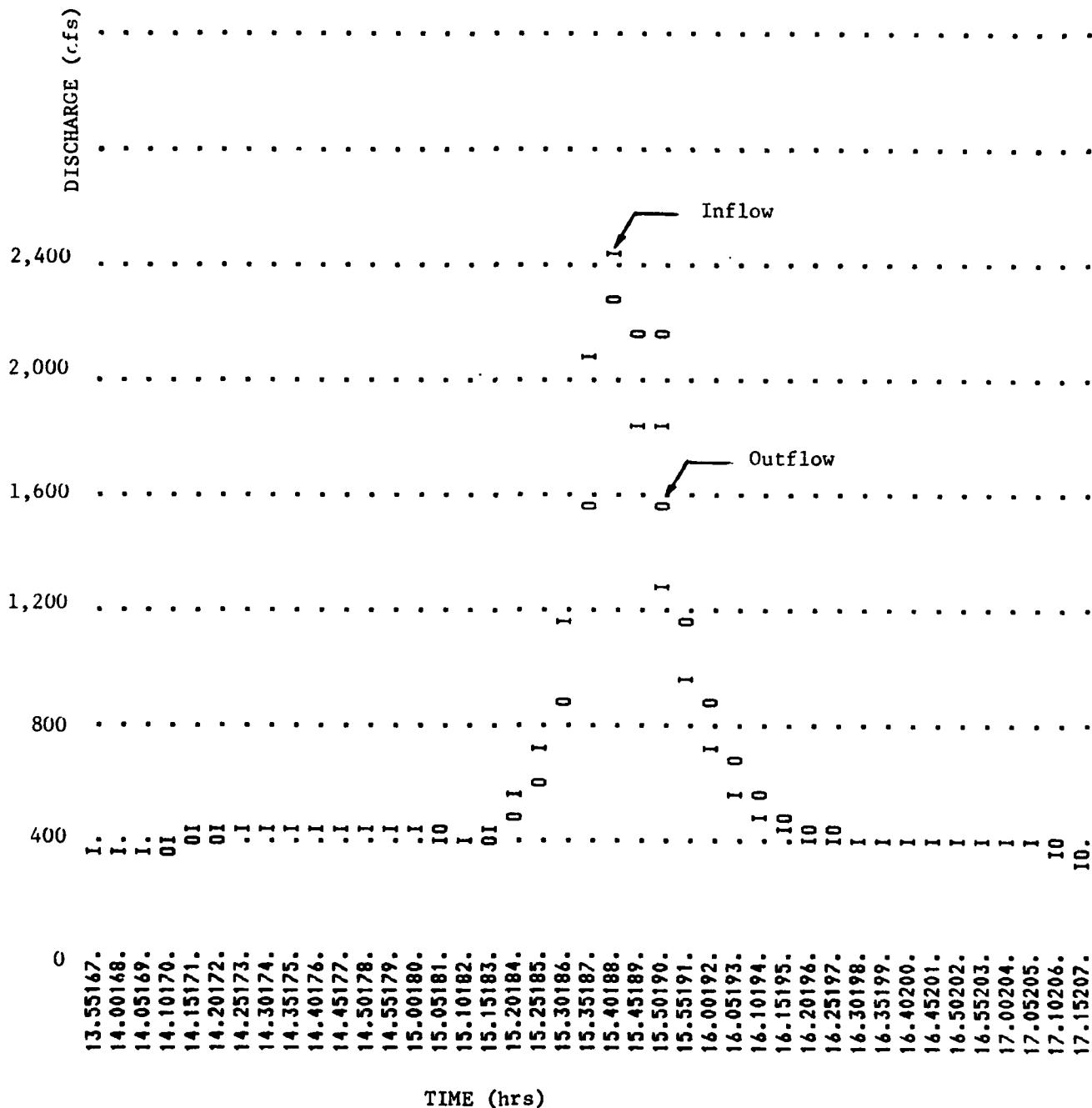
PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	STORAGE	393.50	393.50	395.70
	OUTFLOW	54.0.	54.0.	69.150.

PLAN 1	RATIO OF RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TDP	MAX OUTFLOW	TIME OF FAILURE
	0.10	395.05	0.00	65.	82.	0.00	16.00
	0.15	395.61	0.00	68.	139.	0.00	15.92
	0.20	396.00	0.30	71.	237.	0.58	15.83
	0.25	396.20	0.50	73.	401.	0.83	15.75
	0.30	396.35	0.65	74.	590.	1.17	15.75
	0.40	396.52	0.82	75.	850.	2.75	15.75
	0.50	396.65	0.95	76.	1073.	4.33	15.75
	0.75	396.94	1.24	79.	1668.	5.83	15.67
	1.00	397.20	1.50	81.	2270.	6.58	15.67

PMF RATIOS
OUTPUT DATA

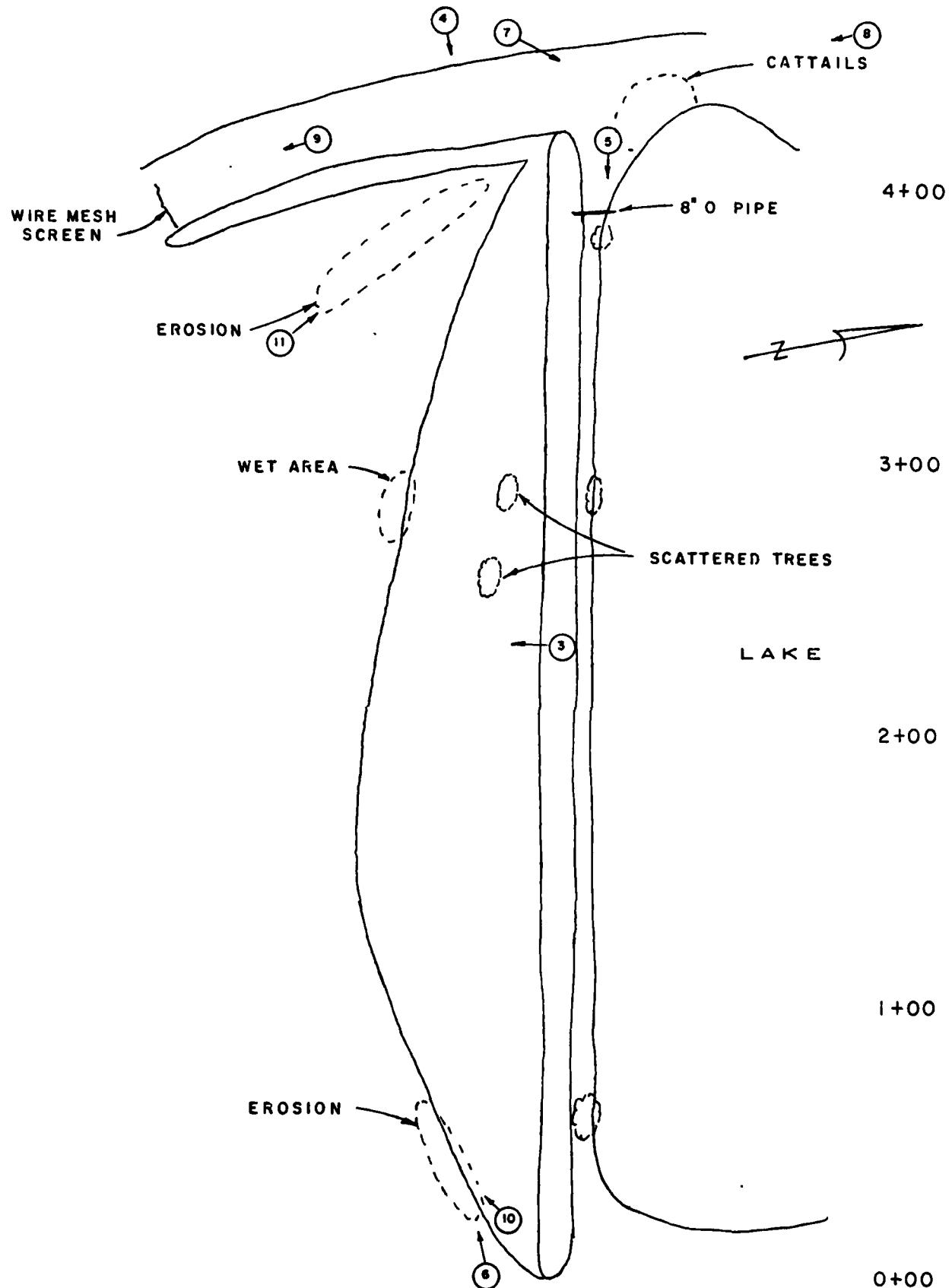
INFLOW-OUTFLOW
HYDROGRAPH
FOR THE PMF

Max. Inflow = 2,454 cfs
Max. Outflow = 2,270 cfs



APPENDIX D

Photographs



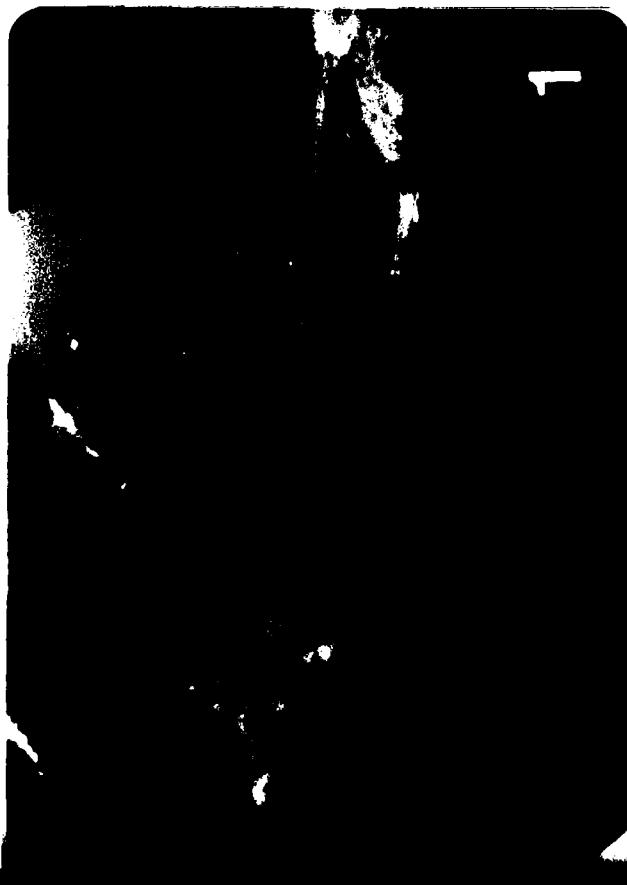
PHOTOGRAPH INDEX
ROLLING HILLS ESTATES LAKE DAM
MO. No. 40077

LIST OF PHOTOGRAPHS

<u>PHOTO NO.</u>	<u>DESCRIPTION</u>
1	Aerial View
2	Aerial View
3	View of Reservoir (Looking North)
4	Crest of Dam (Looking East)
5	Upstream Face of Dam (Looking East)
6	Downstream Face of Dam (Looking West)
7	Spillway Inlet (Looking Northeast)
8	Spillway Channel (Looking South)
9	Spillway Channel Outlet (Looking South)
10	East Abutment-Embankment Contact (Looking Southwest)
11	West Abutment-Embankment Contact (Looking Northwest)
12	Downstream Hazard Feature (0.71 mi) (Looking North)



4



1

